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Automatic Approach for Detection of Abnormality within MRI Dental Images Using Gaussian Filtering and SVM Hybridization

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ABSTRACT

Dental care is state of the art problem, which must be detected at early stage in order to overcome severities. To tackle the problem proposed system uses multiple techniques present within image processing and hybridized it. Proposed system uses pre-processing is performed to improve quality of images using modified Gaussian filtering, feature extraction process is performed in order to determine critical and non-critical segments, morphological filtering mechanism is applied to determine the teeth ends to be classified properly and support vector machine is applied to classify the disease to appropriate class. Results are obtained in terms of classification accuracy and mean square error. Overall simulation is conducted within MATLAB 2017 and result is 99% in terms of accuracy.

Keywords: Classification accuracy, Dental Caries, Image Processing, Mean square error, Pre-processing, SVM.

I. INTRODUCTION

Dental image analysis brought dental care medical scheme to new heights. Automated approach leads to better classification accuracy. To tackle the issue of dental problems several machine learning mechanisms being invented. This paper presents in-depth study of dental care schemes and proposed a new technique of dental image analysis by modifying pre-processing phase along with support vector machine for classification phase. Image processing mechanism includes phases, by following those phases features are extracted and training to the artificial neural network is made. These techniques includes: pre-processing, segmentation and classification [1]. Integral to this vision is the capacity to identify caries injuries at a beginning time and accurately evaluate the level of mineral deficiency, guaranteeing that the right intercession is prompted [2].

Figure1. The stages of caries development

A. Artificial Neural Network for the Detection of Tooth Problems

The inability to detect problems at early stage causes severity and even tooth decay. In order to overcome the problem artificial neural network and machine learning mechanisms becomes useful. One of the techniques associated with machine learning is support vector machine. Support vector machine is critically based on hyper planes. Hyper-plane is a line dividing the entire region into two parts. One part denotes the region that may be corrupted and other part may distinguish non-corrupted part. In

other part, SVM is capable of dividing the image segment into critical and non- critical segments [3].

B. Support Vector Machine for Image analysis

SVM not only is used to divide the image into critical and non- critical segments but also used in order to classify the image segment [4]. In case we have two class labels then the image segment after application of SVM may result into following

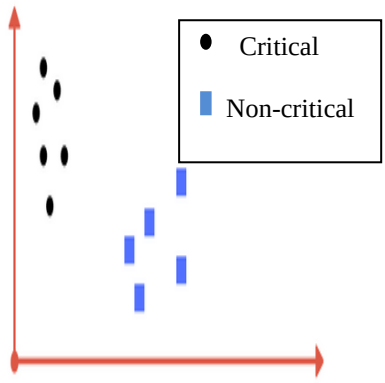


Figure2. Clustering of critical and non- critical segments through SVM

Image analysis process must be preceded by image pre-processing. Image pre-processing phase include resizing and noise removal schemes. Noise removal is critical since analysis process is affected greatly by the use of noise handling mechanisms. Median filter and Gaussian filters are commonly used mechanism to tackle the noise. Median filter is capable of handling salt and pepper noise but is incapable of handling smoothening issue. In order to resolve the problems Gaussian-filtering scheme is used in the proposed work. Risk factors involve in the dental images are discussed first which are tackled in the proposed literature [5].

C. Early Mechanisms for detection of Tooth decay

The point of this examination was to think about the adequacy of clinical and radiographic (utilizing Image Representation of radiograph) strategies for caries conclusion. They were clinically analysed for the nearness of dental caries utilizing the WHO (World health organization) criteria. Left and right Image Representation of radiographs were taken after the clinical examination to distinguish dental caries. Clinical examination found extra 4 occlusal caries (beginning caries) that were not analysed radio graphically and radiographic examination uncovered extra 20 approximal surface caries that were not obvious clinically in deciduous teeth. In perpetual teeth, 3 extra occlusal caries were analysed clinically while just single extra approximal caries was analysed radio graphically [6]. These perceptions uncovered the extra symptomatic benefit of Image Representation of radiograph in the analysis of approximal caries in youngsters and the significance of clinical examinations in conclusion of early occlusal caries (nascent caries) which are hard to see on dental radiographs[7]. In perspective of these discoveries, the utilization of Image Representation of radiographs joined with cautious clinical examination will be of incredible preferred standpoint in early recognition of caries in kids.[8]

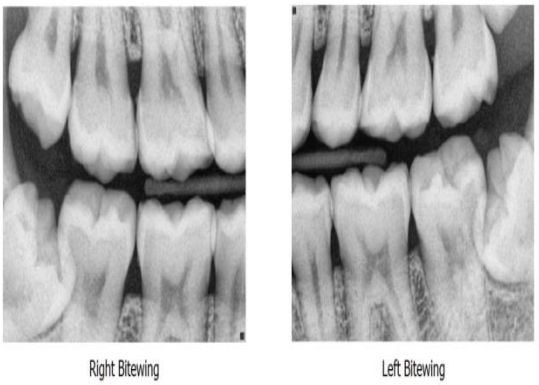


Figure 3. Image Representation of Dental X-rays

D. Visual Examination in terms of X-Rays

Visual examination and testing of suspect sores are helpful for recognizing occlusion caries, however accomplish no pick up of sensitivity and might cause irreversible tooth harm [9]. However, chomp wing radiography recognizes early approximate sores superior to clinical examination and testing the injury; a few curios, for example, cervical burnout may prompt misdiagnosis by impersonating the proximal carious injuries [15]. For that reason, the demonstrative execution of nibble wing radiography

contrasts in the identification of carious injuries relying upon the site of the teeth. Despite the fact that early approximate caries that happen inside the lacquer layer can be distinguished unmistakably, chomp wing radiography is not useful for early determination of occlusion caries in light of superimposition of finish layer [10]. In spite of the fact that chomp wing radiographs are exceptionally helpful in the conclusion of cavitated approximate caries, it involves utilization of ionizing radiation, which is not appropriate for pregnant ladies and youngsters. Also, specialists must be knowledgeable to play out the radiologic strategy for chomp wing radiograph for counteracting superfluous radiation presentation [11]. The FOTI is a snappy and economical technique that can improve visual examination of all tooth surface. But accomplishment of this strategy relies upon adjustment and change made by the specialist [12].

E. Computer Vision

PC vision is the science and innovation that compare to the vision of machines. As a logical aspect, PC vision is the procedure to get data from pictures by building a manufactured framework [17]. This pictures information can be exhibited to the framework in many structures, the most well known perspectives from a solitary camera, video arrangement, sees from numerous cameras, or multi-dimensional information from a therapeutic scanner [13, 14]. The established issue in PC vision is that of deciding if the picture information contains some particular protest, highlight, or action. This undertaking can regularly be tackled vigorously and without effort by a human, yet is as yet not tastefully explained in PC vision for the general case: discretionary questions in self-assertive circumstances. The existing techniques for managing this issue can, best case scenario tackle it just for particular objects, for example, basic geometric items, human faces, printed or manually written characters, or vehicles, and in particular circumstances, ordinarily portrayed regarding very much characterized brightening, foundation, and stance of the question in respect to the camera in [18,19]. There is an assortment of acknowledgment issue, for example,

1) **Recognition**: This issue comprises in the acknowledgment of articles that were pre-indicated or learned by the framework.
2) **Identification**: As the name recommends the principle objective in this issue is to identify individuals, recognize people, this can be satisfy by the utilization of the individual face, fingertips, teeth shape, and so forth.
3) **Detection**: Our work fits in this acknowledgment issue, on the grounds that the principle objective is to recognize, in the picture, areas containing dental caries. For this situation the purpose of catching the pictures, is effectively restricted for location of dental caries.

II. LITERATURE SURVEY

P.Panday et al. [20] presented a powerful division technique utilizing a combinational approach of Local Gaussian Distribution fitting vitality alongside level sets. Here the nearby forces of pictures are characterized by Gaussian circulations, which are joined with the level set capacity for precise divisions of teeth shape. The exploratory outcomes demonstrate that division accomplishes the less number of cycles making it computationally quick and work continuously circumstance. In [21, 22] they proposed a viable plan to section every tooth in periodical radiographs. The strategy comprises of four phases: picture improvement utilizing versatile power law change, neighborhood peculiarity examination utilizing Holder type, tooth acknowledgment utilizing Otsu's thresholding and associated segment investigation, and tooth outline utilizing snake limit following and morphological activities[21].Proposed a model for Dental CT picture shape extraction method. The principle objective of

this approach is to make utilization of the consequence of this procedure as an underlying advance in a mechanized Dental ID framework [15]. W.G.M.Garaets et al. [16] Presented indicative imaging; human recognition is the most conspicuous, yet minimum contemplated, wellspring of mistake. A superior comprehension of picture recognition will enhance indicative execution. This investigation centres around the view of coarseness of trabecular examples on dental radiographs. Examination of human vision with machine vision should yield learning on human recognition. S.Chang et al. [23] they displayed the datasets, techniques and aftereffects of the test and set out the standards for future employments of this benchmark. The principle commitments of the test incorporate the creation of the dental life systems information storehouse of Image Representation of radiographs, the formation of the anatomical anomaly classification information vault of Cephalometric radiographs, and the meaning of target quantitative assessment for examination and positioning of the calculations. Nazemi, A. & Maleki [24] proposed a support vector machine mechanism to detect hand postures. This is critical in the detection of biometrics. The biometrics enhances security mechanism and is critical in nowadays world since maliciousness is growing. Meenakshi et al. [25] Presented application based on mobile for diabetes mellitus prediction: FHIR Standard. In [26] proposed a mechanism in the detection of diabetic retinopathy. Support vector machine for the segmentation and classification process is used in this case. The SVM based approach is used to extract features as well from the image. The classification accuracy is high by the use of said technique. Satone et al. [27] proposed a machine learning mechanism including principal component analysis for accurately detection of face. Feature extraction is done using support vector machine where as verification is done using support vector machine. Daliman et al. [28] proposed a mechanism including GLCM and SVM approach for oil palm problems. The detection process includes segmentation and classification. The segmentation process is used to perform critical and non-critical part extraction and classification used to determine the problem present within the area. Result is presented in terms of classification accuracy. In [29, 30] Proposed a mechanism to detect skin lesion within the image. Support vector machine is used to perform the said operation. Image is divided into critical and non-critical segments using this literature. Result is presented in terms of classification accuracy.

III. METHODOLOGY AND PROPOSED WORK

The proposed system consists of image acquisition process. The dataset of teeth is used for this purpose, which is derived from:

"http://www.dentalcare.com/enus/research/media-library" and derived images are colored. In order to use these images within the proposed system first of all the images must be converted into gray scale form. The characteristics of the images used within the proposed system are of size: 256x256, format: jpeg and type: coloured.

The proposed system once converts the image into gray scale form and then applies the edge map algorithm to determine the boundary of the segments of the image with the help of Sobel filter. Once edges are identified, training to the network using Otsu thresholding is made. Training process is accompanied by the enhanced Gaussian filtering to smoothen the boundaries of the image set which may be disturbed by the use of Otsu thresholding mechanism. Morphological operation is applied to identify any abnormality or distinguishment present within the observed image. Feature extracted during the previous phase is compared against the test data to determine the problems if any, which is predicted using masking operation at the second last phase using support vector machine. At the last phase, result is displayed in terms of accuracy and other parameters such as mean square error, time and entropy. The flow of the proposed system is given as under:

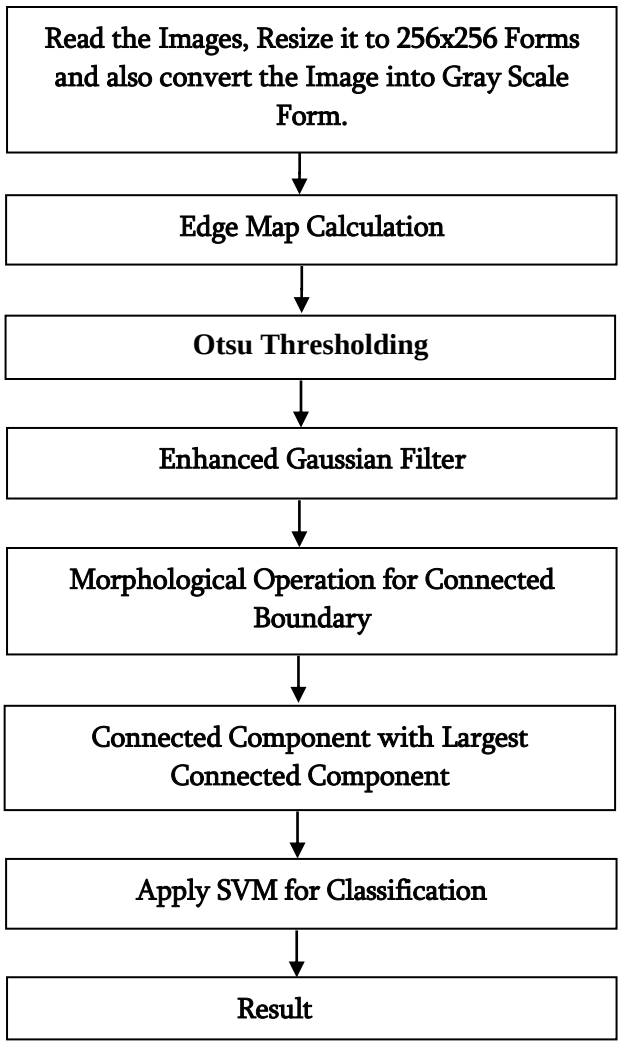


Figure 4. Proposed Work

Algorithm for proposed work as follows:-

Algorithm

1. Read the image from online source using Imread.
   I= imread (image);
2. Calculate edge map
   Map=emap (image);
3. Apply Otsu method for segmentation
   I1=Otsu (image);
4. Apply enhanced Gaussian filter for noise handling and display the features accurately.
5. Identify boundary of the region by applying morphological operation.
6. Apply the mask on original image and perform classification using SVM.
7. Display the result in terms of accuracy.

IV. RESULT ANALYSIS

Firstly, we load an abnormal image to identify the caries and numbers of calculations are performed to obtain its stages, which are given below:

A. **Edge map calculation-** An edge is connected pixels that are lying on the boundary between two regions and differs only in pixel intensity. This is used to identify the object and signify discontinuities in image.

(a) Original Image (b) Sobel Filter

Figure 5. Image Representation of Edge Map Calculation

B. **Otsu Thresholding-** Thresholding is used to extract the object from its background by assigning an intensity value for each pixel to differentiate each pixel as object point or background point. Otsu threshold method is used minimize the within class variance of the threshold black and white pixels. This method operates directly on the gray level histogram so it is fast.

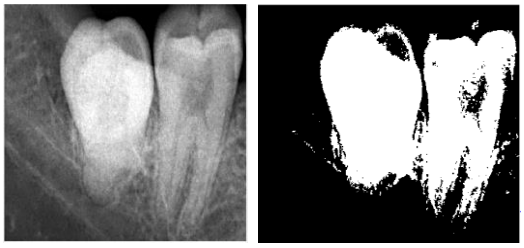
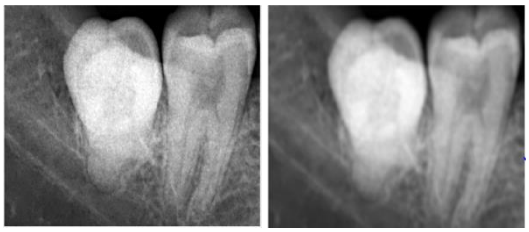


Figure 6. (a)Original Image (b) Otsuthresholding

C. **Enhanced Gaussian Filter-** It is used not only to enhance the image but also resizing the image overlapping pixels are critically handled by the use of modified Gaussian filter. Image smoothening is also performed by the use of this mechanism.



(a) Original Image (b) Smoothening Image

Figure 7. Image Representation of Enhanced Gaussian Filter

D. **Morphological Operation**-Morphology processes the images on the basis of shapes. It applies a structuring element to an input image to create an output image of the same size. In this operation, the comparisons between input images with its neighbors are based on the value of each pixel in the output image. To construct a morphological operation we choose the size and shape of the neighboring pixels.

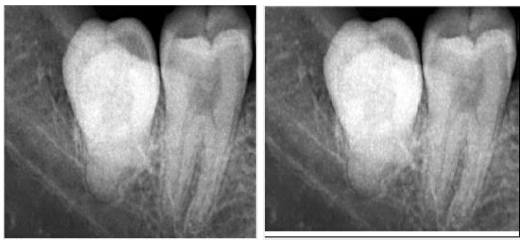


Figure 7. (a) Original Image (b) Dilated Image

(c)Eroded Image (d) Opening of Image

(e) Closing of Image

Figure 8. Image Representation of Morphological Operation

We obtain the results on following parameters, which are given below on the basis of existing and proposed method:

A. **Time:** Time consumption is calculated using the following formula

$$Time = \sum_{i=1}^{n} (Finish_i - start_i)$$

Where n is the total number of images within the dataset.

Table 1. Time Parameter

Parameter	Existing	Proposed
Image 1	1.59046	1.64816
Image2	1.59811	1.65203
Image3	1.57466	1.62015
Image4	1.67101	2.11628
Image 5	1.69133	1.82912

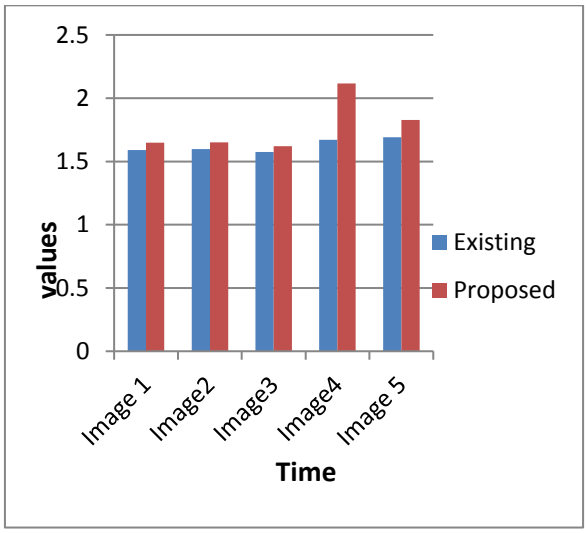


Figure 9. Time Parameter

B. **Accuracy:** Accuracy is obtained using the following formula:

$$Accuracy = \sum_{i=1}^{n} (x - x_a)$$

Where x is the actual value and x_a is the approximate value.

Table 2. Accuracy Parameter

Parameter	Existing	Proposed
Image1	98.8332	99.7803
Image2	94.923	98.7308
Image3	94.9836	99.0851
Image4	96.3403	99.3718
Image5	97.4872	99.1748

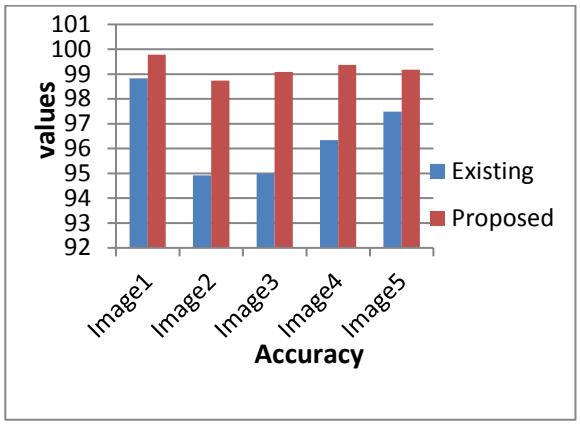


Figure10. Accuracy Parameter

C. MSE (Mean Square Error): Mean square error must be low and is evaluated as

$$MSE = \sum_{a=1}^{n} \frac{(x - x_a)^2}{n}$$

Where n is the total number of images evaluated. X is the original value and x_a is the approximated value of feature obtained from simulation.

Table 3. MSE Parameter

Parameter	Existing	Proposed
Image1	1.16676	0.29168
Image2	5.07699	1.26925
Image3	5.01637	1.25409
Image4	3.65973	0.914932
Image5	2.51281	0.37792

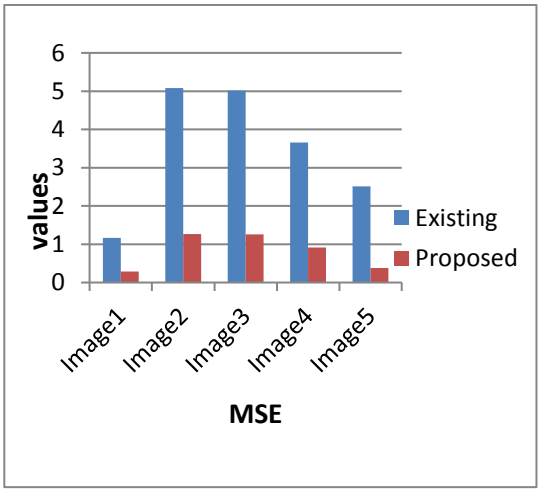


Figure11. MSE Parameter

D. Entropy: Entropy indicates degree of relationship between the pixel which is obtained as follows

$$Entropy = \sum_{i=1}^{n} P_i log_2 P_i$$

Where P is the probability that difference between the two adjacent pixels is i.

Table 4. Entropy Parameter

Parameter	Existing	Proposed
Image1	5.06172	7.06172
Image2	6.533384	7.53384
Image3	6.41469	7.41469
Image4	5.12214	7.12214
Image5	5.54977	7.54977

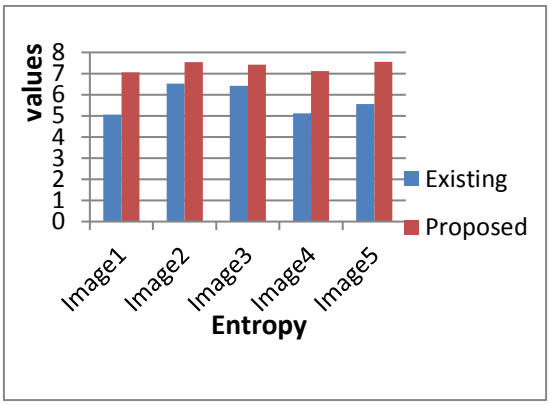


Figure12. Entropy Parameter

V. CONCLUSION AND FUTURE SCOPE

Dental care in medical field is critical which is used to determine the problems within the teeth at early stage. The proposed work uses support vector machine at classification stage to predict disease. Classification accuracy is high since at the pre-processing stage Gaussian smoothening is used in place of median filtering. Median filtering cannot smoothen the image but the Gaussian smoothening mechanism can easily smoothen the image and present the image set to edge detection phase. The proposed system produced better result in terms of classification accuracy. The result is improved by 4% proving worth of the study. In future J48, random forest can also be used as a classification method and compares to identify the better result. The proposal MSE can be further reduced by the use of classification strategy enhancement.

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